



2001 Fire and Cabin Safety  
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Evacuation Studies Session

HUMAN FACTORS ASSOCIATED WITH THE CERTIFICATION  
OF AIRPLANE PASSENGER SEATS:  
*SEAT BELT ADJUSTMENT AND RELEASE*

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# TWO HUMAN FACTORS RELATED ISSUES STUDIED

- *LAP BELT TENSION*
- *LIFT LATCH ANGLE*



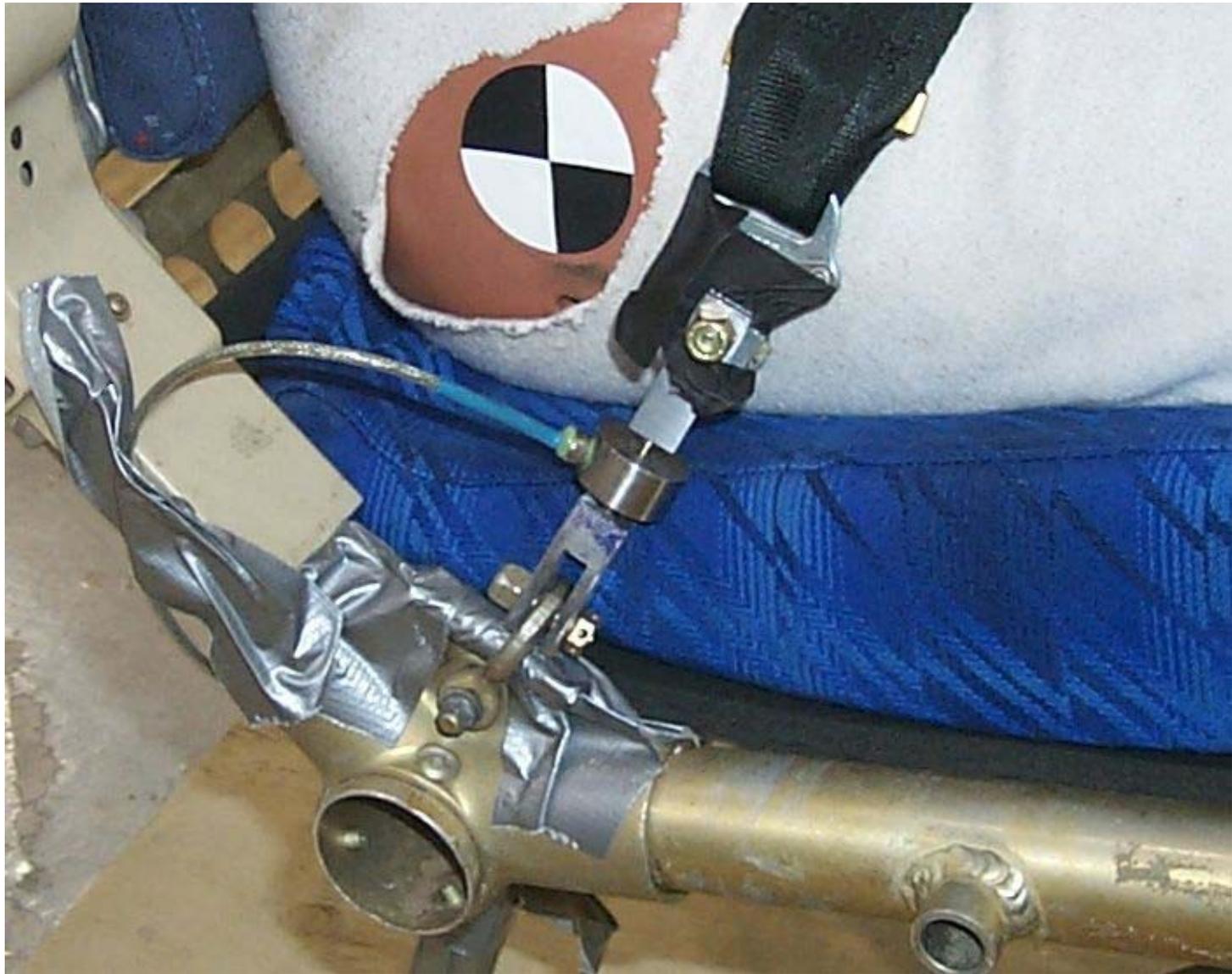
# LAP BELT TENSION

- Data needed as a basis for formulating sled test procedures
- Relate tension measured with people to tension measured with a test dummy
- Evaluate current method of setting pre-test tension.

# Typical commercial passenger seat



Load cell placed in line with a typical lap belt



Data averaged over a 3-second period while subject held breath.





# STUDY PROTOCOL

- Subjects drawn at random from A2E study
- Tension gathered for both normal and emergency landing conditions

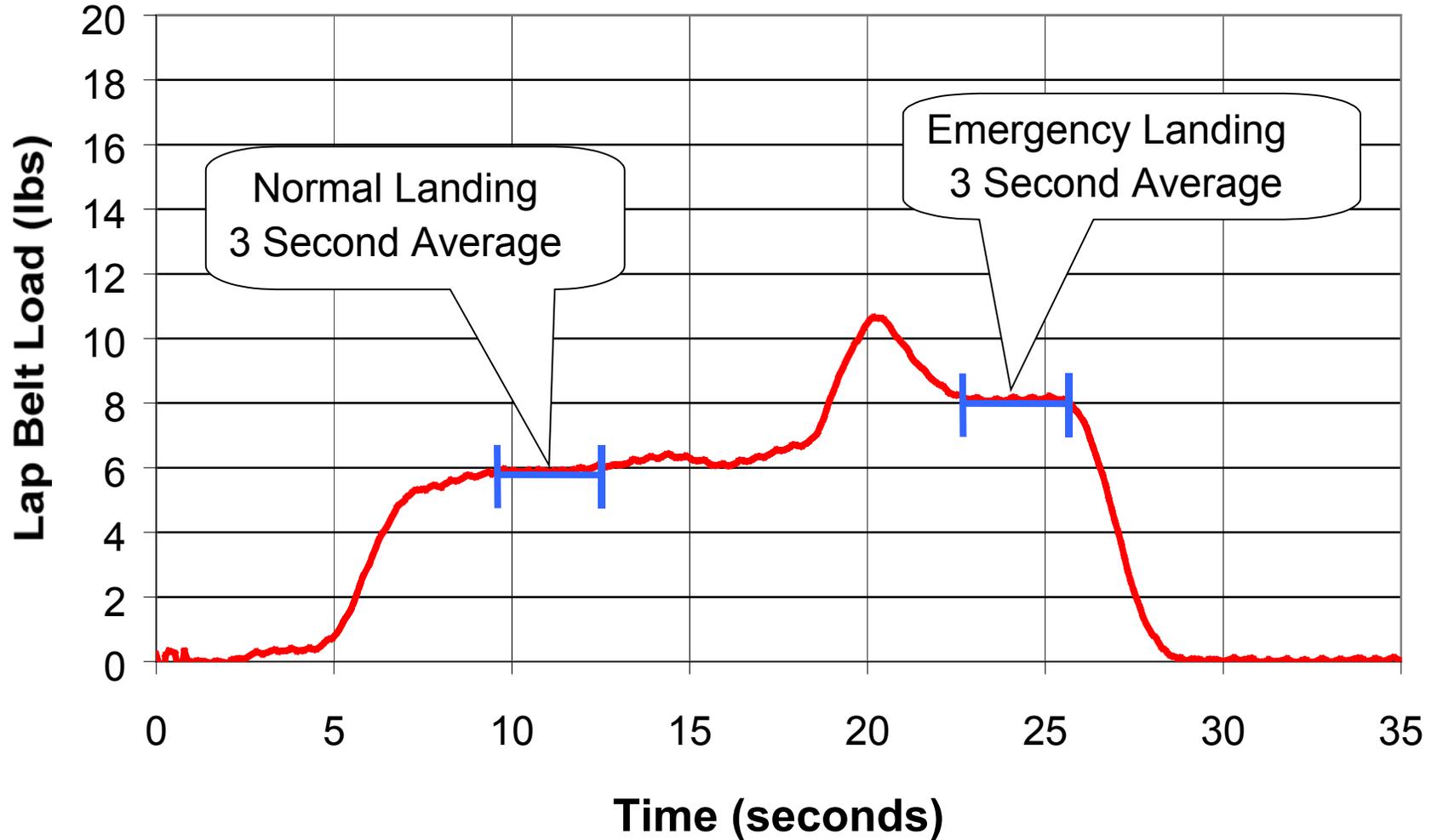


# SUBJECT STATISTICS

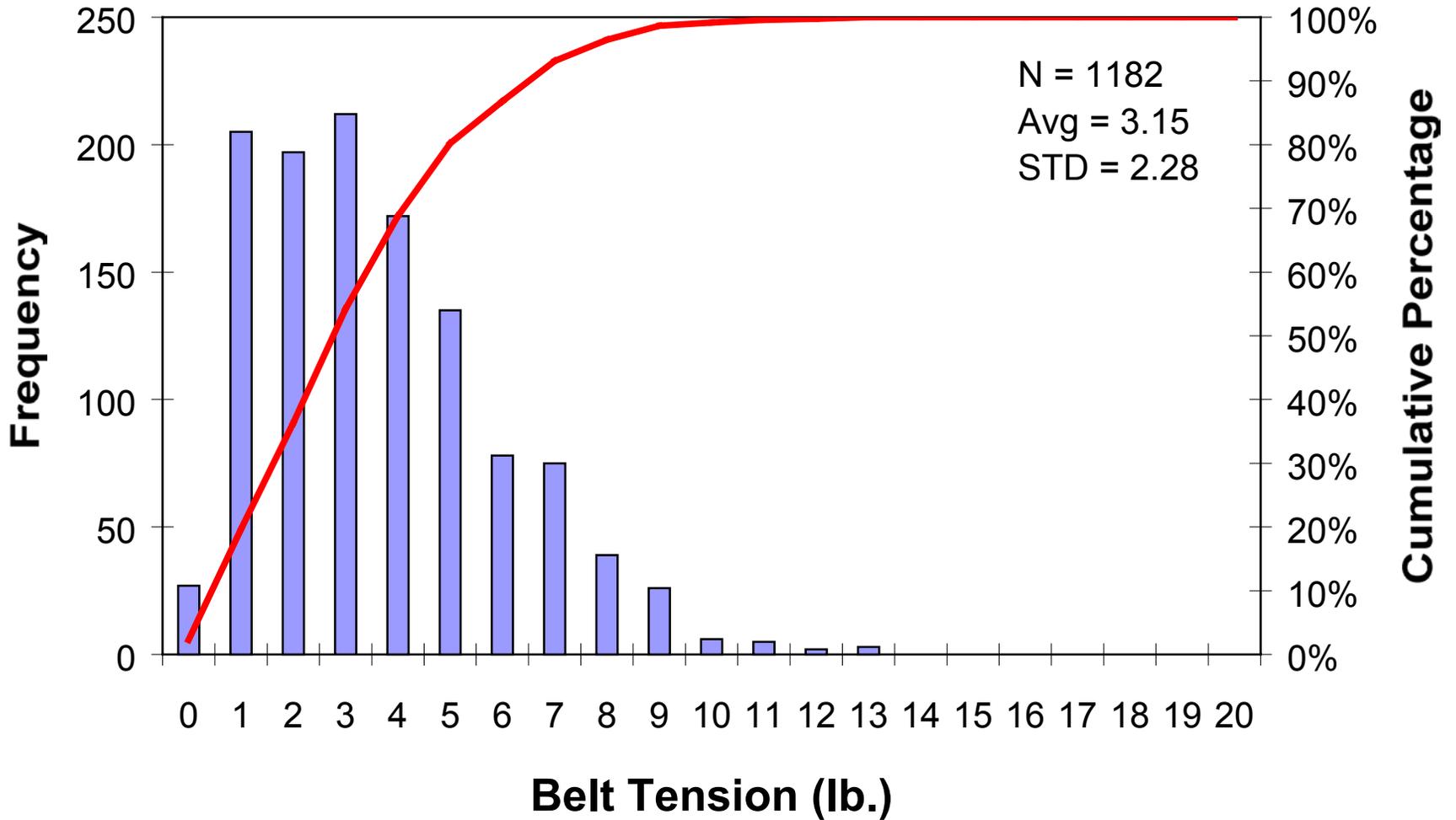
	<b>Age</b>	<b>Weight</b>	<b>Height</b>	<b>Waist</b>
<b>Average</b>	37.8	180.2	68.1	37.0
<b>Max</b>	65.0	359.0	79.7	60.2
<b>Min</b>	18.0	81.4	57.8	24.4

**N = 1182    587 males    595 females**

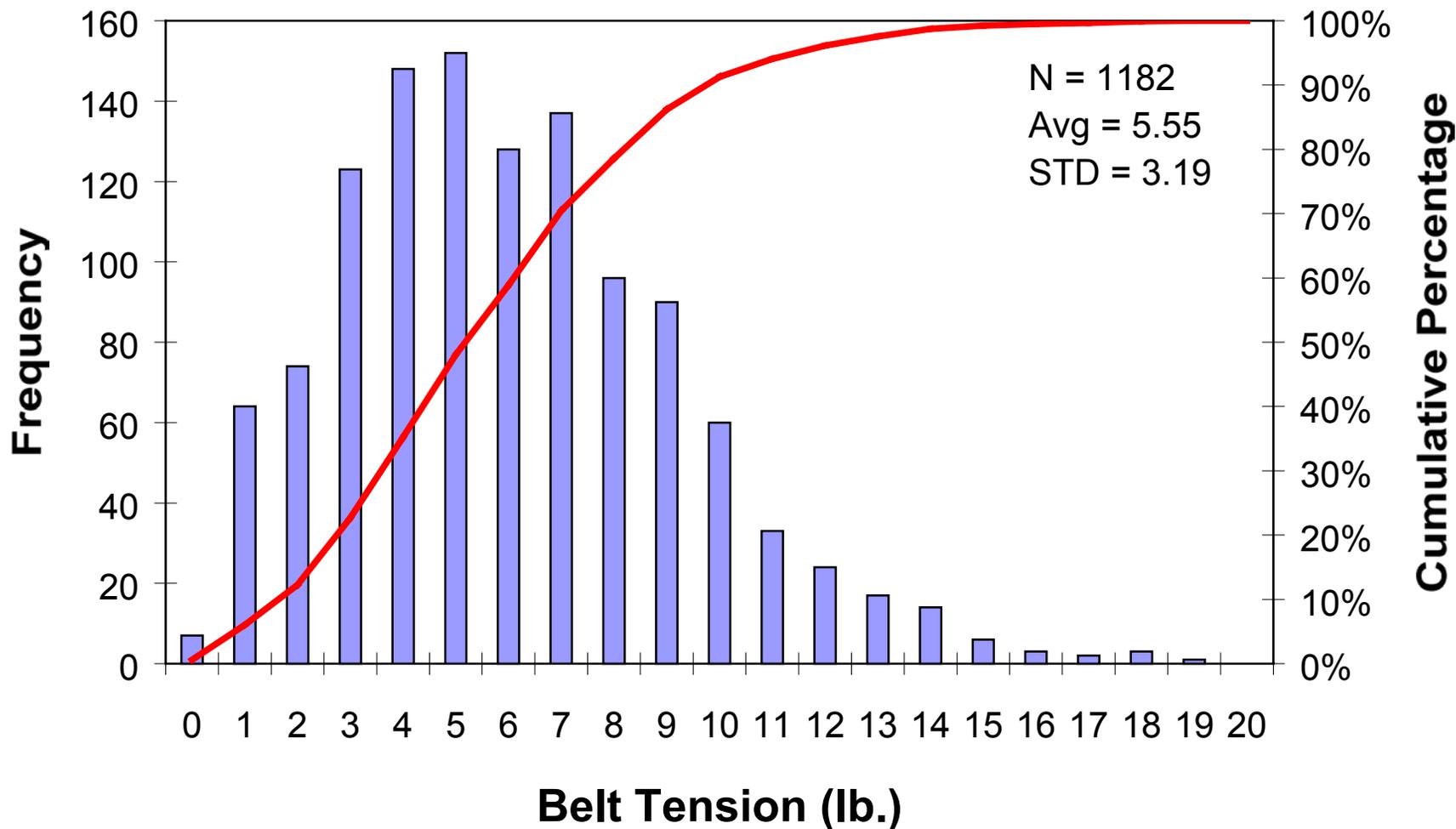
# Typical Lap Belt Adjustment Time History



# Normal Lap Belt Tension



# Emergency Lap Belt Tension





# SUBJECT RESULTS

- Average Normal tension was 3.2 lb. , with 90% of all readings less than 7 lb.
- Average Emergency tension was 5.5 lb., with 90% of all reading less than 10 lb.



# SUBJECT RESPONSE TO AN EMERGENCY LANDING

- 14 % of subjects chose not to adjust their belt
- 77 % of subjects tightened their belt somewhat
- 9 % of subjects actually loosened their belt (inadvertently, in most cases)



# SUBJECT RESPONSE TO AN EMERGENCY LANDING

- Some subjects felt they would need to loosen their belt to assume the brace for impact position.
- Some subjects stated they would unlatch the belt before landing so they could get out quickly.



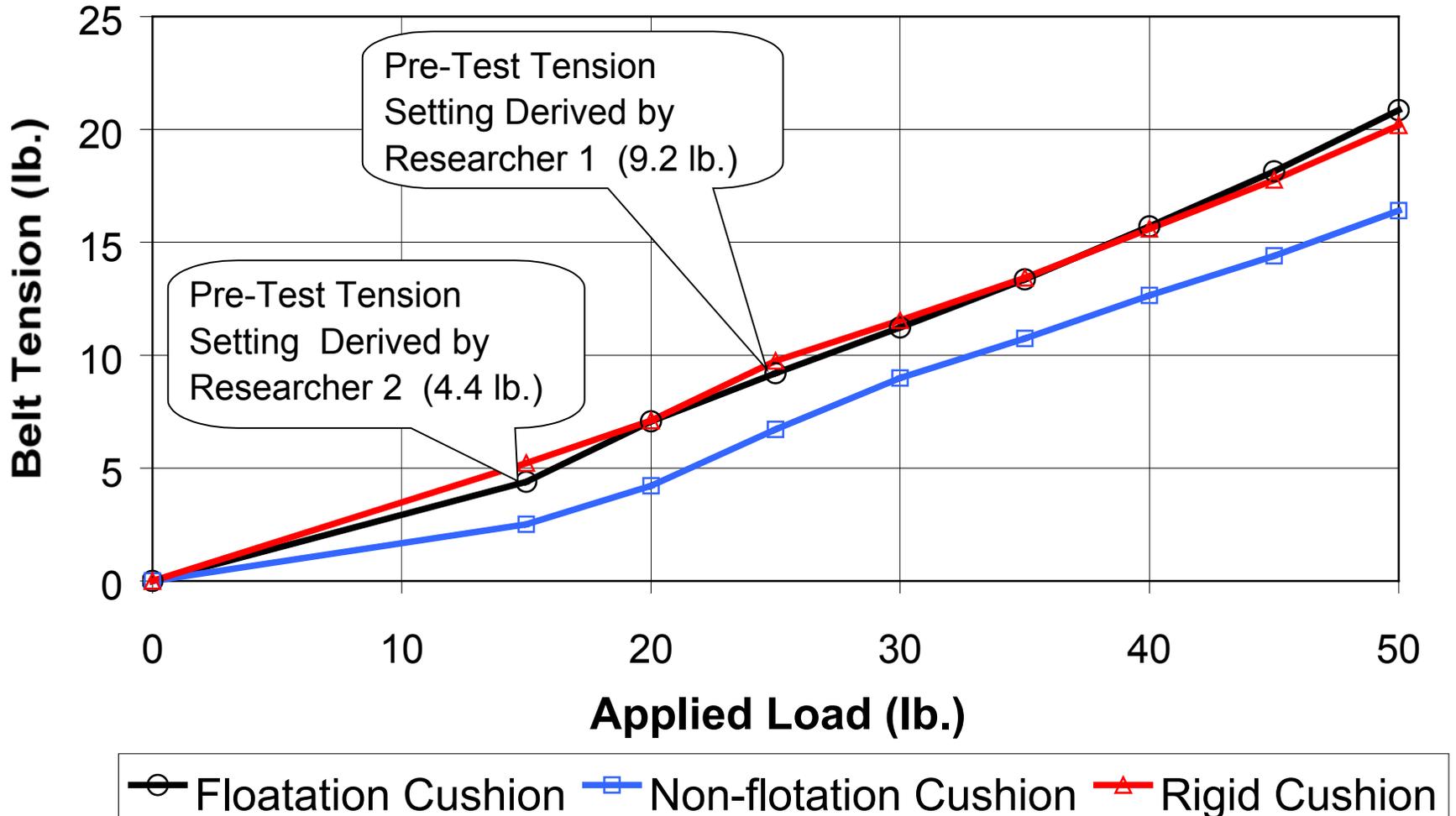
# ATD BELT TENSION

- 50% Hybrid II Anthropomorphic Test Dummy (ATD)
- Applied tension, belt tension, and ATD position measured
- Three cushions used:
  - Floatation cushion used with subjects
  - Soft non-flotation cushion
  - Rigid block

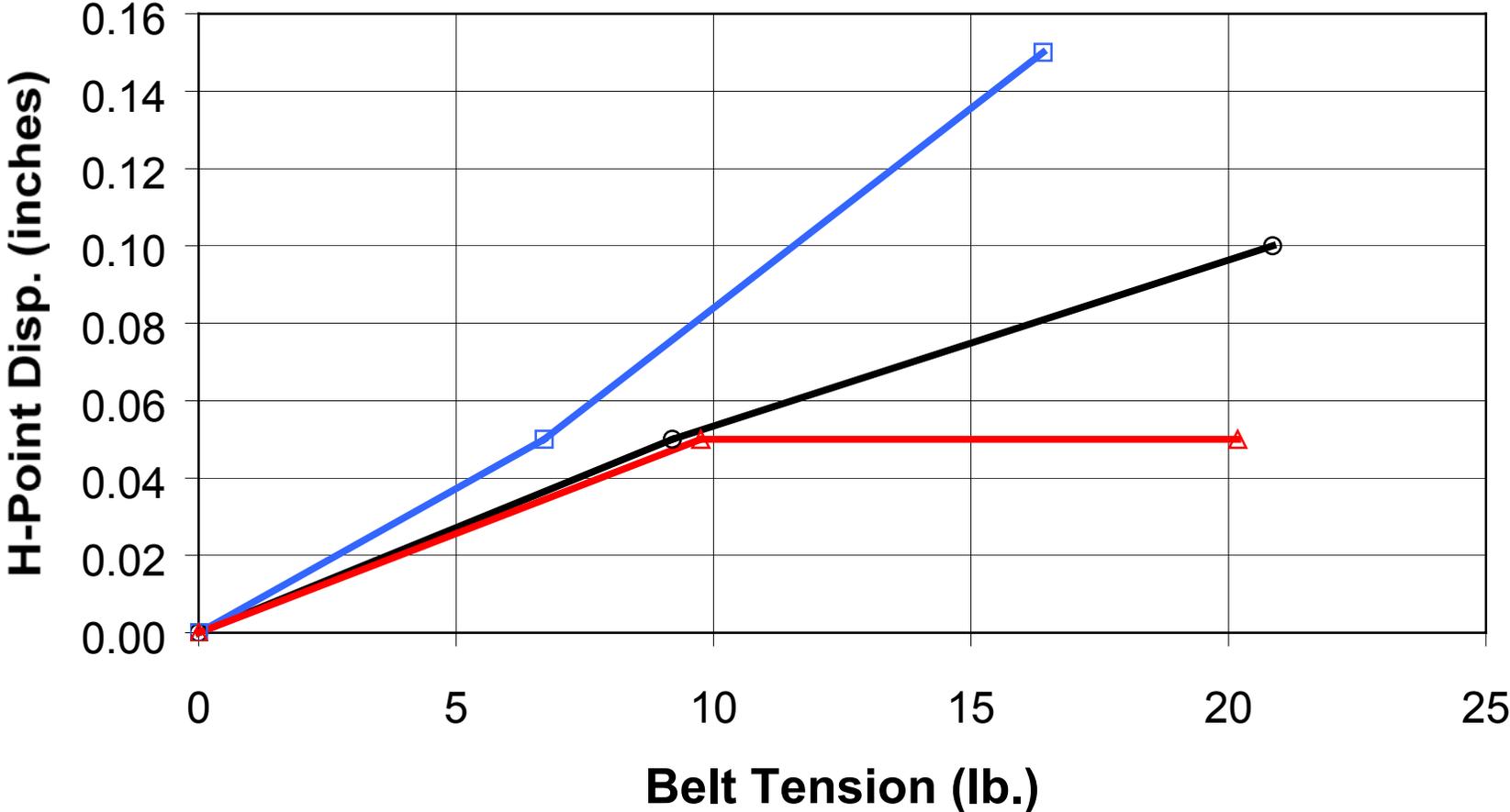
# Load Applied Incrementally



# Lap Belt Tension vs Load Applied to Free End of Webbing



# ATD Pelvis Vertical Deflection vs Lap Belt Tension



—○— Floatation Cushion    —□— Non-flotation Cushion    —△— Rigid Cushion



# BELT TENSION CONCLUSIONS

- Passengers don't tighten their lap belts very tight
- Current sled test procedures result in reasonable tension settings.



# LIFT LATCH ANGLE

- US belt buckles traditionally built to release between 30 and 45 degrees
- British regulations require between 70 and 95 degrees
- Desire for harmonization prompts study



# SETUP AND INSTRUMENTATION

- Typical triple-place, commercial passenger seat
- 30, 60, and 90 degree lift latch buckles installed at each seat position.
- Belts instrumented to gather release time
- Button on table 4 feet in front of each seat to gather egress time

# Lift Latch Study Setup





# STUDY PROTOCOL

- Subjects drawn at random from A2E study
- Subjects instructed to try each of the three belt configurations
- Subjects instructed to release the belt and press the button as quickly as possible



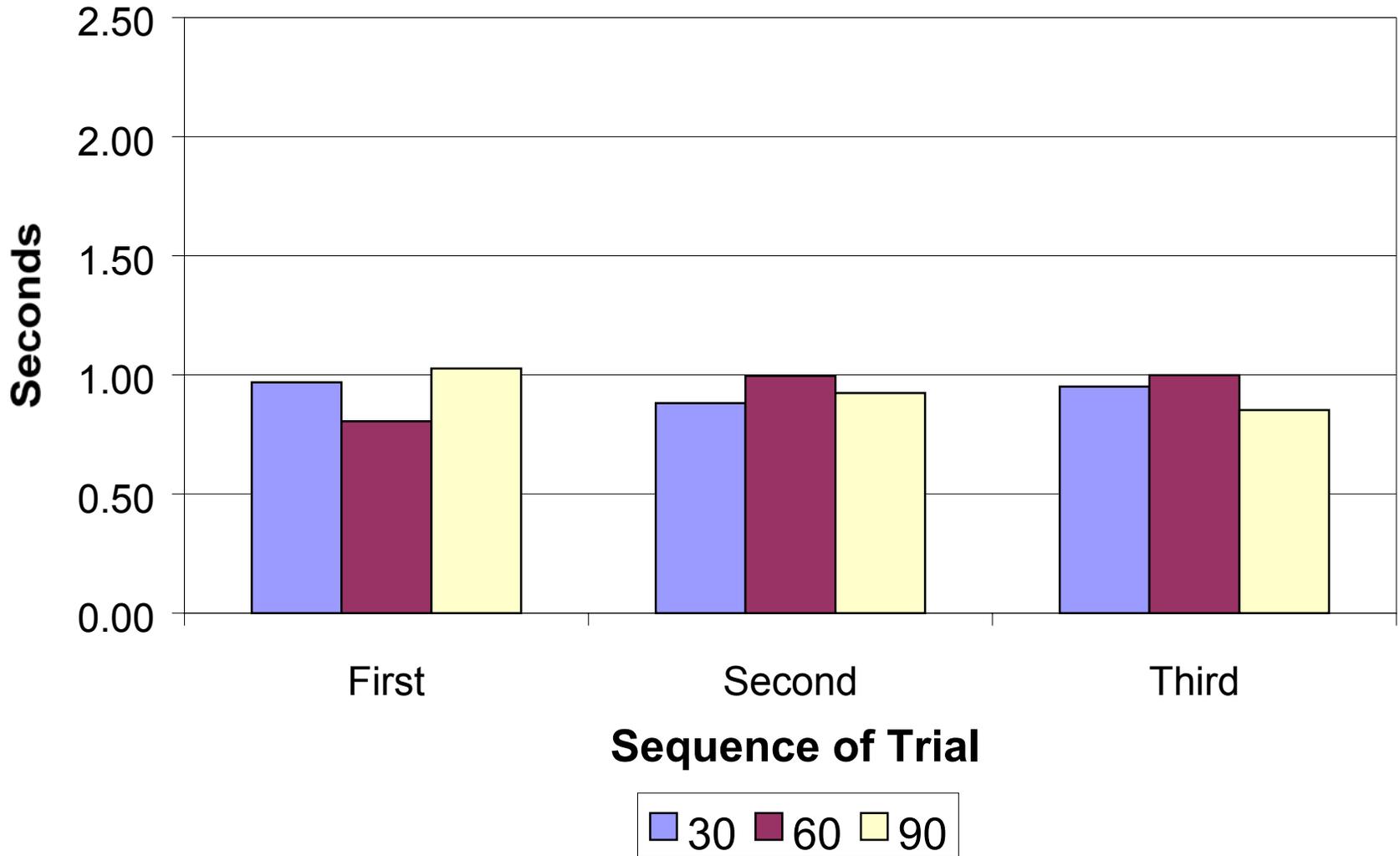


# SUBJECT STATISTICS

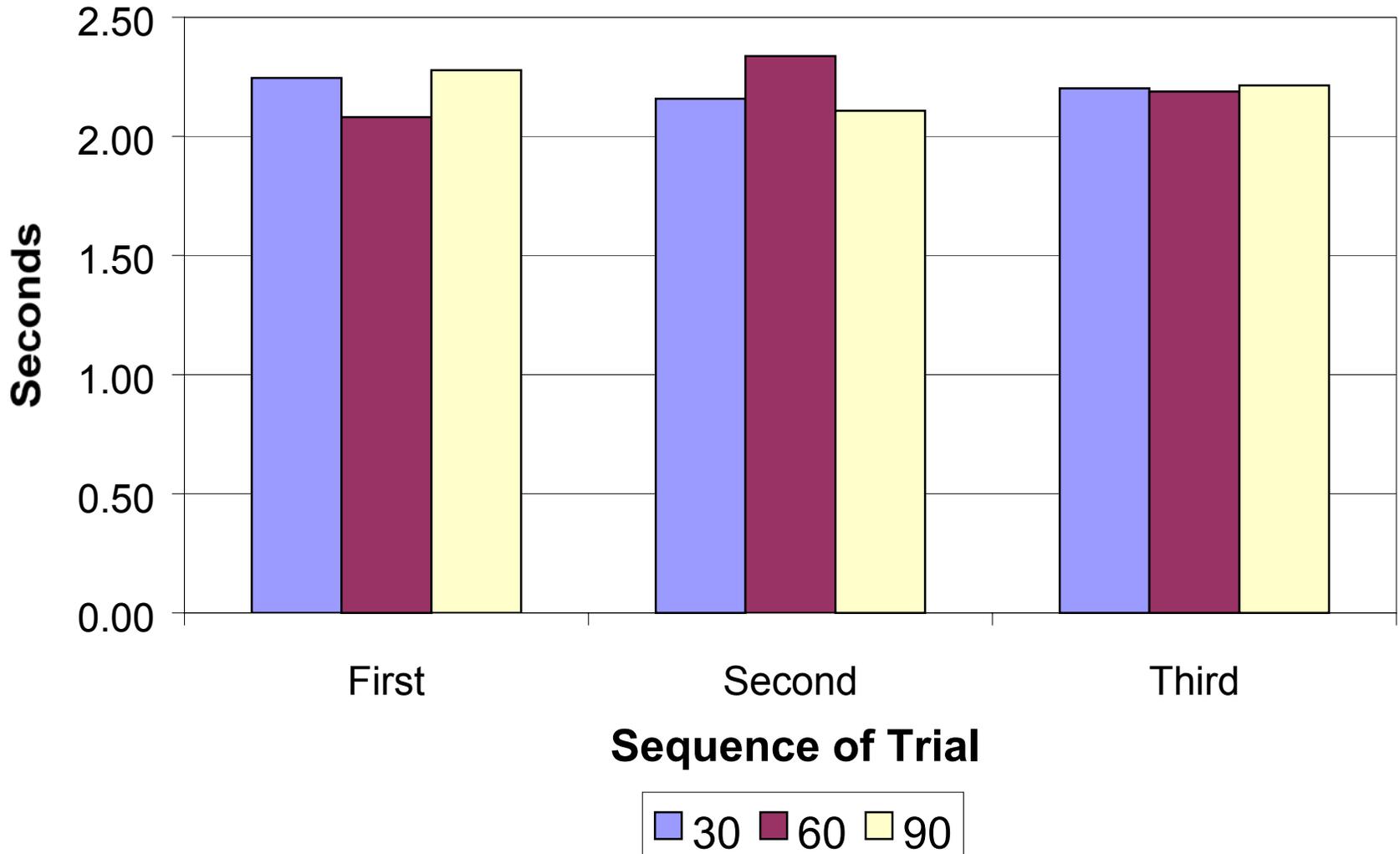
	<b>Age</b>	<b>Weight</b>	<b>Height</b>	<b>Waist</b>
<b>Average</b>	36.3	177.7	68.3	36.2
<b>Max</b>	65.0	322.7	77.2	54.7
<b>Min</b>	18.0	99.4	60.3	26.0

**N = 201    107 males    94 females**

# Average Latch Release Time



# Average Egress Time





# SUBJECT RESULTS

- No significant difference between the three lift latch configurations
- Maximum release time was only 2.85 seconds.
- 15 subjects (8% of the group) had to try at least twice to release the latch
- Of these double attempts, over half were with the 90 degree buckle



# LATCH ANGLE CONCLUSIONS

- Most occupants pull the lift lever over 90 degrees
- This action negates any differences between the lift latch release angles